Flynn's Field Files
Week 3
June 21-29, 2007

Underground fuel tank floating on surface. (Enlarge image)

Left to right: Chuck and Roger of Greenwood Aviation. (Enlarge image)

Matt Newburn measuring volatile organic compounds (VOCs) on the G-1 return ferry flight. (Enlarge image)

Bev Johnson

Craig Strait

Ruth Keefe

Rahul Zaveri

Daily Log - June 29, 2007

Goodbyes are tough for me. As excited as I am to go home and to see my loved ones, I don't like to say goodbye and break the bonds of friendships newly formed. We have worked long hard hours, endured many of the same deprivations being away from home. As a group we've shared times of anticipation—Will the weather let up? Will we fly? We've struggled together to overcome challenges, suffered through some disappointments, but also celebrated accomplishments. There is a special quality to friendships formed under such intense conditions. There is almost the sense that you've been friends for years even though you may only have met some of these people a few weeks before. It is illusory of course.

It really has only been a few weeks, but perhaps there is something real to it as well? Through the long hours and the combined effort, we inevitably reveal elements of our true character.

Take for example Chuck Greenwood, the owner and manager of Greenwood Aviation housing all of our aircraft based in Ponca City. On the night before the last day of the CHAPS field campaign we received another torrent of rain. Shortly after 6:00 AM, the ground was so saturated with water that this formerly underground fuel tank literally floated up to the surface. The white-painted steel pipe snapped like twigs. The steel cables anchoring the tank to cement foundations ripped apart like string. This calamity represents tens of thousands of dollars of damage. Unperturbed, Chuck and his team immediately set about mitigating the destruction and preparing for the repair. And, unbelievably to me, without missing so much as a single beat, Chuck himself helped prepare the G-1 for an on-time departure as though nothing else were as important to him at that moment—the consummate professional.

Goodbye Ponca City, goodbye Oklahoma, and goodbye to Greenwood Aviation! We'll miss you, but we'll be back.

All of the researchers and staff in the field would have been helpless if not for the incredible support provided back at the lab. As this is my first time working with the G-1 in the field, my perspective is necessarily limited, but I specifically want to recognize the outstanding effort and assistance of Bev Johnson (admin), Ruth Keefe (admin), Craig Strait (computer programmer), and Rahul Zaveri (researcher). Their long hours toiling away on (until now) thankless jobs have been crucial to the success of this experiment. My hat is off to you!

The research is still not finished! During the G-1's "ferry flight" back home, we continued to operate aerosol sampling instrumentation.

And, to those of you who have followed this running commentary from the CHAPS/CLASIC field experiment—thanks very much! It meant a lot to know we hadn't been forgotten by our friends and families back at home. Goodbye, farewell, and thanks for reading!

From left to right, King Air crew chiefs Scott Sims and Dale Bowser. (Enlarge image)

Downward-looking High Spectral Resolution Lidar (HSRL). (Enlarge image)

The King Air team from left to right: Dale Bowser, Rick Yasky, Chris Hostetler, Les Kagey, Tony Cook, and Scott Sims. Not pictured: Mike Wusk, John Hair, Rich Ferrare, Dave Harper, and Mike Obland. (Enlarge image)

Daily Log - June 28, 2007

Yesterday our flight to southwest Kansas was scrubbed when the desired conditions didn't develop in time. This morning the weather in southwest Kansas is more favorable, but the weather in Ponca City is worse. Our pilot, Bob Hannigan, dropped by the situation room to explain that with severe weather threatening we needed to shorten our flight plan so that if weather prevented landing in Ponca City, the G-1 could fly to an alternate runway. Given the distance to the nearest "safe harbor" it didn't look possible to get beyond this stormy region to find any of the puffy cumulous clouds we want to study. Before we quit and straightened out the details, it was time for the 10:00 AM weather briefing. The forecast was for worsening conditions over the next several days with severe weather expected at OKC and Ponca City. It was decided that the next G-1 flight will be destined for home. In short, the research flights for CHAPS are officially over—but our work in Ponca is not yet done. The instruments need end-of-mission calibrations. Then, we need to pack and ship everything carefully and quickly.

The King Air mission is also finished. The King Air was the primary flight partner for the G-1 during this experiment. It flew a path coordinated with the G-1 flight track, flying high overhead and using a downward pointing high-spectral resolution lidar (the HSRL) to measure the vertical distribution of aerosols below. A real-time display available on the ground provided us with detailed vertical information to help decide the altitude at which the G-1 should fly. It was great flying with you! You were truly "King of the Air"!

Here is a picture of me pitching in with Haf Jonsson, NPS/CIRPAS, and Gunnar Senum, BNL, calibrating the single-particle sizing instruments aboard the G-1, PCASP and CAPS. (Enlarge image)

The playbook for Southwestern Kansas.

Daily Log - June 27, 2007
Today, I spent the first part of the day in the Situation Room. The weather really kept us hopping!

The previous evening, the local conditions near Oklahoma City did not look very useful for our study, so we submitted a flight plan that would take us into Southwestern Kansas instead. However, in the morning, there was an intense storm system over that location.

Our flight plans generally need to be submitted about three hours in advance, but the weather conditions were changing hourly. It was a very interesting dance. We found ourselves repeatedly pushing back the intended departure time.

We would be studying several displays covering a possible target area: the radar maps showing precipitation, the GOES satellite imagery showing the clouds viewed from above, the reports from meteorology stations, and even the first-hand accounts from visiting pilots after they had landed in Ponca City. We frequently saw favorable conditions pop up, but they would last less than an hour.

While watching one area that looked promising, we would keep half an eye on other nearby regions for possible opportunities. All the while, we had to consider whether conditions in Ponca City would be safe for take-off and landing. It would be pointless to plan a mission based on the conditions over the target area if the take-off and landing conditions were unfavorable.

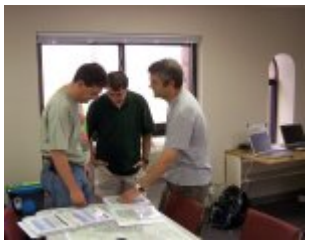
And of course, we're not just sending out our planes for a joy ride. The potential science goals that would be served by the flight are always at the forefront.

Months before the mission began, the flight scientists assembled a "playbook" stocked with numerous preplanned missions. These represent templates containing coordinated altitudes and locations of several aircraft. The airspeed and instrument complement of the different aircraft have been matched up to maximize their utility. These templates may be quickly modified to suite the local conditions.

The repeated delays are tough on the aircraft teams. While held in a constant state of readiness to fly, other activities are curtailed. For example, it is difficult to have instruments disassembled for testing while flight preparations are underway. After pushing back the departure time two successive times, the flight teams were eager for a definitive "go / no-go" decision.

With some reluctance, our flight plans for the day were cancelled. Because I had been in the Situation Room attempting to coordinate the flights, I felt a sense of loss that we were forced to call off the flight. But without delay, the instrument team on the G-1 sprang into action, eager to get back to work on their instruments. As far as I could tell, no disappointment at all! They were just as ready to fly as to delve into the equipment, calibrating and getting ready for the next time.

To call this a "down day" just because we didn't fly would be a mischaracterization. Way to go team, you are awesome!



In the Situation Room, PNNL researchers Beat Schmid (left), Jim Mather, and Larry Berg review the aircraft playbook. (Enlarge image)

Jan Nystrom (foreground), our airboss, dicusses air traffic control from the Situation Room. (Enlarge image)

Howie Lewis (left) and Les Kagey, CIRPAS King Air Pilots, and Chris Hostetler, CIRPAS Principal Investigator discuss the day's mission. (Enlarge image)

Daily Log - June 26, 2007
We're in the home stretch!

For the early part of this experiment, I was fully occupied with helping get things set up, assisting people with their internet connections, and working out details with telephones, microphones, projectors, and sound systems. Not exactly atmospheric science, but still quite critical to making it possible for the scientists, pilots, and teams to coordinate this complex operation.

After the initial setup was done, I was thoroughly saturated with learning my roles for the G-1 flight preparations and also the details of my instrumentation. Remember, I'm the "new guy" on this team. Before this campaign, I was a ground-based guy. This is not only my first mission with the G-1; it is my first mission with any aircraft.

Toward the middle of the field experiment, I was getting into a groove. Periodically, things would pop up (such as the lightning storm knocking the network out) that would require immediate adjustments in my work flow. But it's all in the nature of the game during a field campaign.

Now, with less than a week left, my role continues to evolve. I've helped set up a data archive on the internet where the research teams can share preliminary results with each other.

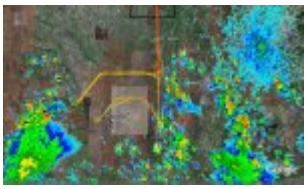
Some scientists prefer to access this archive themselves but others are happy to use me as a go-between, providing their results to me for distribution. I like this go-between role as it gives me a chance to see what others are working on at a basic level and also helps me get a feel for how the preliminary results are shaping up.

Also, I moved my "office" (basically my laptop, camera, and notepad) to the Situation Room today. The Situation Room is where the flight scientists hammer out the plans for the day and we monitor the progress of flights underway.

As I've mentioned in previous entries, I have been using Google Earth to display the position of the G-1 during the flight. Throughout the campaign, I've continued to add additional information, including a display of precipitation reported by regional radar and both visible and infrared satellite images.

These tools have proven to be very valuable for monitoring the G-1 during the mission and helping to anticipate and coordinate changes to the flight plan. Recently, we have started to use them before take-off to assist in planning. Proposed flight plans for each of the aircraft can be shown superimposed on the current weather situation.

I had no idea how dynamic the flight planning was in the situation room. Flight plans, schedules, and science missions change faster than the weather in Oklahoma—and believe you me, that is saying something!



The jaws of a storm closing in on our flight path from the south.
(Enlarge image)

Daily Log - June 25, 2007

Three excellent flights in a row! This morning, our meteorologists suggested favorable conditions, possibly by mid-day, followed by rapidly deteriorating conditions thereafter. Finally, the weather broke in our favor and our forecasters hit the nail right on the head.

After identifying the urban plume to the northwest of Oklahoma City, we flew several superb legs of the Hostetler Half-Hexagon formation.

The Google Earth image shows severe weather closing in on our flight path from the south with the G-1 returning victoriously to Ponca City toward the north. An hour or two after the G-1 landed, the Oklahoma City area in this image would be almost completely obscured amidst severe weather radar echoes.

In the words of CHAPS Chief Scientist Carl Berkowitz:

"It was the flight of the campaign, starting with the G-1 take-off at 11:00 AM, with all instruments working and the weather cooperating. Two layers of clouds were sampled over OKC, with measurements made below, within and above fields of FWCs (fair weather cumulus).

Gunnar noted that the OKC plume was encountered at all three layers and was easily identified by its signature in CO [carbon monoxide]. Betsy saw an increase in the CPC (cloud particle counter) counts, and Liz reported elevated levels of benzene that were correlated with CO. The plume signal was stronger along the inner half-hexagon and weaker, but still present, at the outer half-hex. Liz also reported that the AMS was able to track the size-resolved composition of aerosols along the inner track."

Wahoo!

Twin Otter PCASP, FSSP, and CAPS cloud/aerosol particle sizing probes. (Enlarge image)

Some members of the Twin Otter team: Jesus Galvan (left) and Roy Woods, CIRPAS, and Jason Tomlinson, Texas A&M University. (Enlarge image)

The G-1 (left) and the Twin Otter, nose to nose in the hangar. (Enlarge image)

The Twin Otter prepares to fly the day's mission. (Enlarge image)

Phase Doppler Interferometer for cloud droplet sizing on the Twin Otter. (Enlarge image)

Daily Log - June 24, 2007
Today's flight was much like yesterday. Two successful flight days in a row!

We again used Hostetler's Half-Hexagon as the starting point for another stacked flight with the King Air over the G-1. Severe weather, where "red" precipitation levels were reported by radar, forced us to abandon the eastern-most leg of the plan. Fortunately, the urban plume was detected towards the northwest of Oklahoma City, so it was no problem to sacrifice the eastern leg.

In addition to the G-1 and King Air, the CIRPAS (Center for Interdisciplinary Remotely Piloted Aircraft Studies) Twin Otter also had a great flight. The Twin Otter shares the same hangar with the G-1.

The Twin Otter and G-1 also share some similar cloud and aerosol instrumentation. The PCASP (passive cavity aerosol spectrometer probe), CAPS (cloud, aerosol, and particle sizing probe), and FSSP (forward scattering spectrometer probe) are cloud and aerosol sizing probes operated by Haf Jonsson.

Patrick Chuang's Phase Doppler Interferometer aboard the Twin Otter is designed to accurately measure the size distribution of larger cloud particles and rain drops. This is an important piece of information to help identify precipitating clouds, so we are looking forward to beneficial collaboration with the Twin Otter.

The Hostetler Half-Hexagons - A great flight pattern for us.
(Enlarge image)

Daily Log - June 23, 2007
After yesterday's aborted take off, my spirit was buoyed this morning by a successful AM flight. I felt no small amount of relief when the G-1 transitioned smoothly from external ground power to its own generator and inverters. Excellent! The take off was smooth and without a hitch.

Today, we flew a new flight pattern, dubbed the "Hostetler Half-Hexagons." A key element of our mission involves sampling the urban plume of pollution and aerosols wafted downwind from Oklahoma City. The flight plans must be submitted in advance, but the winds in the OKC area have been unpredictable due to a circulating low pressure system to the south of us. Depending on the motion of that low pressure system, the location of the urban plume can change dramatically.

A half-hexagonal pattern was selected stemming from a brilliant suggestion by Chris Hostetler of NASA Langley. This pattern was designed to increase the chances of locating the urban plume. The flight could then be tailored in response to severe weather or other weather patterns by dropping legs.

This pattern was a great success! The G-1 and the King Air flew a coordinated flight with the King Air flying above and ahead of the G-1 while probing the atmosphere with a down-looking lidar. The lidar uses a laser to map the distribution of clouds and aerosols below. Both the King Air and the G-1 identified the urban plume. The G-1 followed behind with intensive detailed measurements of the clouds and aerosols.

John Hubbe changing the inverter in the tail of the G-1 - it's a tight fit. (Enlarge image)

Daily Log - June 22, 2007
There is nothing quite like getting all the engines spun up only to have to call the flight off at the last minute. That's what happened today.

The weather was looking good, and we were on time for a noon take-off. Both engines had started fine, and I had already disconnected the G-1 from external power when our pilot Bob Hannigan unexpectedly gave the signal to reconnect the power cables. I asked myself, "Reconnect! What could have happened?"

I re-attached all three lines - the 28 volt direct current (VDC) umbilical for the engines, as well as the belly plugs with 115 and 230 volts alternating current (VAC). Then, the engines were turned off, the crew disembarked, and the aircraft was towed back into the hangar. Their disappointment was palpable.

I soon learned that a power inverter aboard the G-1 had failed. A power inverter is an electrical component that converts the 28 VDC electricity from the airplane generators into "normal" 115 and 230 VAC required by most consumer products and by much of our scientific instrumentation.

Without the inverter we were effectively grounded. Several parallel efforts were initiated at once. Technical manuals were consulted and poured over. Calls were placed to the vendor for technical assistance. A search to purchase a replacement was begun.

Each of these parallel efforts paid dividends. The vendor provided good technical assistance. Unfortunately, the vendor does not keep replacements on hand and estimated a time-frame for replacement of several weeks. However, with the technical aspects of the problem understood, we determined that the faulty inverter could be replaced with one of two unused inverters already in hand. In principle, the problem was solved!

Well, it may look easy on paper but the actual hardware is difficult to access due to cramped quarters in the tail of the airplane. John Hubbe and Matt Newburn worked the rest of the afternoon to make the replacement and perform the testing.

Meanwhile, the search for a replacement unit was successful. We located a spare inverter in Houston that could be shipped to us overnight just to make sure we had another spare on hand.

As we rolled out the aircraft for the flight the next day, the Fed Ex truck arrived with the spare inverter. When the G-1 took off for a successful flight, there was plenty of satisfaction to go around.

The Cessna-206 is fitted with instruments to measure aerosol optical properties. During this field campaign, the C-206 has been augmented with instrumentation to measure carbon dioxide. The spear-shaped device on the wing is not a rifle or a phaser. It is the aerosol sample inlet. It draws ambient air to the instrumentation within the aircraft. (Enlarge image)

Pat Sheridan, NOAA

Daily Log - June 21, 2007

Is it too soon to start a count-down? Counting today there are nine days left in the field experiment.

For me that means only nine more days of getting up around 5:15 AM, not leaving the hangar until about 7:15 PM, and working in the hotel until late. Nine days until I can have my first day off in over a month. Nine days until I come home to a belated birthday party for my son Taran who turned 3 years old this month. Nine days until I see my wife Donna and baby daughter Tovi. Sometimes nine days seems too long.

But it is also nine days before I bid farewell to friends, new and old, that I've met here. Nine more days of anticipation, and effort and intensity - watching the weather, working like mad, comparing results! Only nine days left in beautiful Oklahoma where the air is so clean and the colors are so bright that you'd think you just stepped foot in Oz. So, at the same time those nine days can seem too short and fly too fast. Field work is HARD work, but it is good work.

The G-1 did not fly again today due to unfavorable weather forecasts, but we were no less busy for it. A "down-day" is NOT a day off. It is a day to tuck your chin down and dive into the instrumentation or the data. I spent the first part of the day completing final repairs to the computer network after the thunderstorms the night before last. (I'm not a network administrator; but I play one on field campaigns.)

While I was working on network issues, several members of the G-1 team worked to rearrange and adjust electrical loads on the aircraft and re-plumbed aerosol sample lines. This kind of fine tuning and tweaking is a constant activity in the field as we try to optimize configurations in response to conditions on the aircraft, instrument behavior, and specific mission goals.

In a previous log entry, I said I'd show some of the other research teams. This light aircraft is a Cessna- 206 operated by the ARM AVP program. It shares the hangar with the G-1. While light, the C-206 is loaded with instrumentation for measuring aerosol optical properties. This aircraft and its predecessor, the Cessna-72N, have been flying routine low altitude missions over the ARM Southern Great Plains site for seven years for comparisons to the surface-based aerosols measurements. This long-running time series is a one-of-a-kind data set. It represents a monumental achievement thanks to John Ogren, Pat Sheridan, and the entire aerosol group at NOAA.

During this field campaign, the C-206 has been augmented with instrumentation to measure carbon dioxide as well in support of research by Margaret Torn, Marc Fischer, and Sebastien Biraud.

Flynn's Field Files

Week 2

June 16-20, 2007

CAPS - Cloud, Aerosol, and Particle Sizing probe (Enlarge image)

Daily Log - June 20, 2007
A tough decision: weather or not to fly? Please forgive the pun, but I couldn't help it. Mother Nature has been giving our forecasters a particularly hard time.

Last night we had an extremely energetic storm with more than 4000 lightning strikes in the Ponca City area and tens of thousands throughout Oklahoma City. As you might expect, this wreaked havoc on our internet access. The vigor of the storm also wreaked havoc with the forecasting models we use to help plan our flight missions.

We flew a mission today with flight legs running east-west. The legs were located to the north and south of Oklahoma City. These were supposed to be upwind and downwind [of OKC] legs. However, the wind direction changed such that our flight legs were nearly parallel to the wind, basically scrapping the intended mission plan.

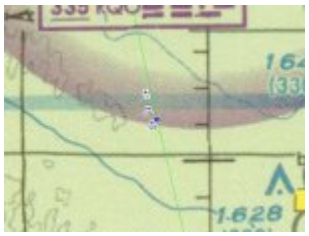
Yi-Nan Lee, BNL (Enlarge image)

But, we are nothing if not flexible. Because of the stormy weather the night before and the fact that the flight tracks did not sample air that had passed through OKC, we measured some of the cleanest air around. The rain had scrubbed the air of pollutants, so we were able to obtain a very clean low baseline measurement.

Stephen Springston, BNL (Enlarge image)

Some of the researchers were astounded at how low the particulate levels were. We are all happy to have the "zero" measurement on our graphs filled in now and is eager to add more data points with higher numbers!

Here are some photos taken from the G-1 during the flight. This was the last day that we'll have Yi-Nan and Stephen with us in Ponca City. They are being relieved by Gunnar Senum who has come back well-rested and eager to work with his CAPS (Cloud, Aerosol, and Particle Sizing) probe. In the remaining days of the field campaign, I'll be making a special effort to get to know the research teams on the other aircraft. Stay tuned!



The tick marks in this blow-up of a sectional aeronautical chart are 1 nautical mile apart. The box labeled C is the target point. All three planes were within one statute mile of the target point at the appointed time, with the Twin Otter winning bragging rights at a separation of only 0.15 mile. All were within 1000 feet of the ground track of the satellites, shown as a thin green line in the image. Enlarge image

Wing-tip-to-wing-tip comparison between the G-1 and the Twin Otter
Enlarge image

Daily Log - June 19, 2007

This morning was mostly clear followed by a gentle build-up of low clouds. It turned out to be a banner flight day not just for the G-1 but for all four additional aircraft: the NASA King Air, the CIRPAS Twin Otter, the Cessna 206, and the Duke University helicopter.

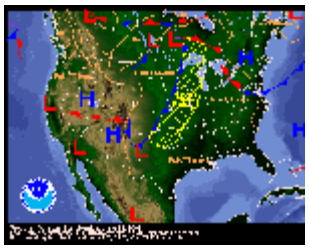
Today we flew a special mission coordinating all the previous aircraft to match up with a group of six NASA Satellites dubbed the "A-Train."

The A-Train satellites have been placed into very closely coordinated orbits so that they sweep past the same place on the surface of the earth within a short time of each other. It is widely recognized that satellites represent the only feasible means of getting widespread global measurements of many important atmospheric and meteorological quantities. In order to make sure that the remote measurements made by the satellites are accurate, it is important to check them against direct measurements taken in the air and on the ground. This is where stacked measurement we took today comes in.

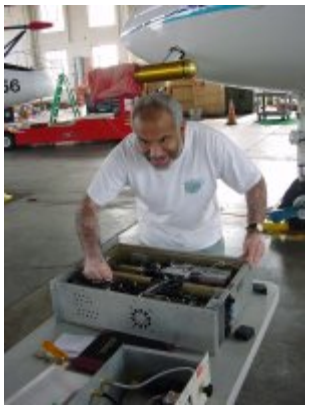
So, how did we do? Here is a snippet from John Ogren of NOAA:

"The GPS logs from the G-1, Cessna 206, and Twin Otter from today's underflight of the A-Train of satellites show just how fabulous our pilots are. The pilots were asked to pass over a given point at a specific time, and the attached plot shows just how close they came. Fortunately, they were assigned different altitudes!"

After the A-Train mission, we also were able to coordinate a wing-tip-to-wing-tip comparison between the G-1 and the Twin Otter. So, not only were we able to help improve the satellite measurements with the A-Train stack, we also gained increased confidence in our direct measurements as well. An excellent day!



The threat of severe thunderstorms kept the planes grounded today. (Enlarge image)



Manvendra Dubey, Los Alamos National Laboratory (Enlarge image)

Daily Log - June 18, 2007
It's another down day today due the potential for potential severe weather. Just look at that band of thunderstorms predicted to pass right across our location in northern Oklahoma. Not exactly the kind of weather we want expose our aircraft, pilots, and researchers to.

Although the aircraft is not flying, we are still plenty busy. As with previous down days, the researchers look over the data from previous flights, verify data quality, and identify discrepancies and potential problems.

I serviced and calibrated the Gerber probe. Successful again, so I'm batting 1000 so far! But as I am learning the ins and outs of this particular probe, I have started to come up with questions concerning finer details not covered by the user's manual. So I called the company and was surprised to find myself speaking to Dr. Hermann Gerber himself - the inventor of the Gerber probe! He described additional technical instructions beyond the scope of the manual and provided some of his insight pertaining to data interpretation.

Over the last week Claudio Mazzoleni, the researcher responsible for the PAPA and LAPA instruments (Pat Arnott Photo-Acoustic and Los Alamos Photo-Acoustic) was relieved by Manvendra Dubey. After arriving here in Ponca City, Dubey lost no time before overhauling virtually the entire LAPA instrument. It may be debatable whether his facial expression in this photo conveys excitement, glee, or mania.

The PAPA and LAPA play a very special role aboard the G-1. When sunlight encounters aerosols suspended in the atmosphere, some fraction of the sunlight is scattered away from the original direction and some fraction is directly absorbed by the aerosols resulting in heating. The amount of absorption is a difficult property to measure accurately, but it is important to get it right in order to model cloud behavior accurately. Interestingly, cloud formation may be either suppressed or enhanced depending on the quantity and distribution of absorbing aerosols.

The PAPA and LAPA are cutting-edge instruments designed to measure this difficult quantity. They operate by producing a laser beam that varies in intensity or strength. Absorbing aerosols are heated by the laser beam and produce an acoustic signal (sound waves) having the same pattern as the variation in the laser beam. An aircraft environment is pretty noisy and has a lot of vibrations which make the photo-acoustic technique difficult. So far though, we are very pleased that the PAPA and LAPA measurements track each other quite well and also correlate nicely with filter-based PSAP (particle soot absorption photometer) absorption measurements.

The G-1 flight pattern for Sunday, June 17, 2007 showing many diversions around thunderstorms. (Enlarge image)

Dick Hone (far left), John Ogren, John Hubbe, Debbie Ronfeld, Stephen Springston, Bob Hannigan, Carl Berkowitz wishing fathers everywhere a Happy Fathers Day. (Enlarge image)

Daily Log - June 17, 2007

Hurray, another successful flight day! Contrary to our hopes and expectations (and the forecasts of meteorologists here and on TV), we did not encounter many of the small, fair weather cumulous clouds that we're after. We did collect some superb data, however, and preliminary results are very exciting. The coordination between the scientists on the ground and the G-1 aircraft team aloft has been really extraordinary, managing to salvage productive missions from chaotic weather conditions.

One of the tools we have been using to achieve this level of coordination is Google Earth. As the Google Earth image shows, the G-1 was kept busy diverting around thunderstorms before returning to the desired flight patterns. On the plus side, the aircraft came back looking nicely rinsed off.

In addition to the radar displays, which show only precipitating clouds, it may be interesting for readers to see satellite images since they show clouds that aren't producing precipitation. Here is a site with good quality GOES satellite images: The National Center for Atmospheric Research - RAP Real-Time Weather Data.

On a completely different note, one unavoidable disadvantage to being in the field is that you miss things back home. The wonders of modern technology do help to bridge that gap. Toward that end, allow me to extend my wishes for a "Happy Father's" day to my own dad and to fathers everywhere. Happy Father's Day, Dad!

The Prede sun photometer has two modes of operation: it can point directly at the sun, tracking it across the sky throughout the day; and it can also be programmed to scan other portions of the sky. (Enlarge image)

Yuck! Look at all that dirt on the lens before I cleaned it! (Enlarge image)

Daily Log - June 16, 2007

Today, the G-1 flight plans were scrubbed due to unfavorable weather. I took this as an opportunity to drive out to the Department of Energy's Southern Great Plains (SGP) ARM Climate Research Facility (http://www.arm.gov/). This facility is the premier climate research facility in the United States, spanning a rectangular region almost 250 miles on edge, centered on the Oklahoma-Kansas border. The SGP facility has more than 200 individual instruments with most of them clustered at a central facility located about 30 minutes south west of Ponca City near Lamont, Oklahoma.

As a national scientific user facility, researchers and vendors are permitted to bring instrumentation to the SGP central facility in order to compare them to the vast array of existing measurements. For an atmospheric scientist, this is an absolutely fantastic place to visit, better than a kid in a candy store. So many different instruments from industry standards to cutting-edge research systems all within walking distance of each other!

Earlier this month, I installed a Prede tracking sun photometer at the SGP central facility to compare to other instruments and make sure that it was operating properly. On the day I installed it, there were clouds blocking the sun preventing a positive alignment with the sun. It also has rained since then, so I wanted to clean the optics and check the alignment. It looked much better after I cleaned it. Unfortunately though, the sky was again clouded, so I could not confirm the alignment of the tracker.

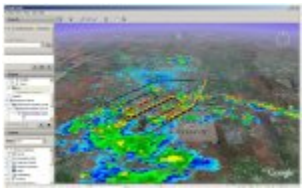
Flynn's Field Files

Bob Hannigan, Pilot

Dick Hone, Pilot

John Ogren, NOAA

Yours truly! PNNL



In the Google Earth image, the black line represents the initial flight plan. The yellow line with red shading shows the G-1 location transmitted to us every 90 seconds. The brightly colored patches indicate rainfall detected by national weather service radar, which provides automatic updates more than once per minute. These weather systems were vigorous, rapidly developing storms. For example, the southern most flight leg was foreshortened to avoid a very active storm cell that had been directly ahead. By the time this image was captured about 30 minutes later, the storm has already moved a considerable distance. (Enlarge image)

Week 1

June 9-15, 2007

Daily Log - June 15, 2007
Another great day! The G-1 flew today and had an outstandingly successful flight.

Due to unfavorable weather conditions this week, it has been a few days since we'd had a science flight. This morning, despite local weather at the hangar threatening rain, our weather forecasters were predicting favorable weather in the surrounding region. There was no mistaking the eagerness and excitement of all the researchers! Wherever I went, people kept asking, "Are we really going? Is it still on? Have you heard any word?"

The flight plan called for mostly level legs at 4000 feet in the hopes of getting plenty of passes through small, fair weather cumulous and that is exactly what we got. Legs are the prescribed flight patterns the pilot follows.

Our weather forecasters Daniel Hartsock and John Harris really hit the nail on the head with this one. Nice call guys!

Special credit also goes to our excellent pilots Bob Hannigan and Dick Hone. Although we found the small, low altitude clouds we were after, they were in the midst of towers of severe storms. Our pilots did a masterful job of diverting around the storms and then recovering the desired flight plan.

The capability to coordinate all of these different elements through Google Earth has been developing right here in the field over the last few days through the efforts of John Ogren (NOAA) and myself. It would not have been possible without the superb website http://radar.weather.gov/ridge/kmzgenerator.php. If you have Google Earth (free download) and would like to see a display of weather in your area or even centered on your home, visit the above site and have fun.

Yin-Nan Lee, BNL

Liz Alexander, PNNL

Matt Newburn, PNNL

Damaged Turbo Pump.
(Enlarge image)

Daily Log - June 14, 2007

Field campaigns come with plenty of opportunities for problem-solving. Today, we discovered that the AMS (Aerosol Mass Spectrometer) operated by Yin-Nan Lee of Brookhaven National Laboratory had experienced a catastrophic failure of one of its turbo pumps. Fortunately, some excellent inter-laboratory collaboration led to a very rapid recovery. We are back on track for a G-1 flight tomorrow and crossing our fingers for good weather.

The AMS helps identify the size and chemical composition of atmospheric aerosol particles. It operates in a high vacuum of about one-billionth atmospheric pressure. To achieve this high vacuum, the AMS uses a turbo pump, which is very similar to a jet turbine. Instead of using valves and compression, the turbo pump uses high-speed turbine blades spinning thousands of times per second.

Sometimes, through normal wear and tear, the bearings in a turbo pump wear out. When this happens, the results are spectacular (as you can see in the photo). Without this critical component, the AMS simply can't function.

However, in the spirit of true collaboration and teamwork, Liz Alexander and Matt Newburn, Pacific Northwest National Laboratory staff, express shipped a replacement turbo pump from their lab in DOE's national scientific user facility at PNNL, the Environmental Molecular Sciences Laboratory. They helped Yin-Nan replace the broken turbo pump in time for the tomorrow's flight. Way to go team!

Larry Kleinman, BNL

This is a whole sky image from one of the remote data sites. It is raining there too!

Three inches of rain fell overnight. – (Enlarge image)

Daily Log - June 13, 2007

Another rainy day in Ponca City, Oklahoma. Boy, did we have a gully washer last night! More than 3 inches of rain fell in some areas over night.

This much rain is about one-fourth of what we get over the entire year back home in Richland, Washington. The forecast is for more of the same for at least the next couple of days.

Flights plans have been scrubbed and many of us are focusing on analyzing data or servicing and tweaking instrumentation.

As for me, I'm trying to learn a new data analysis package. Over the past few years, I have written many thousands of lines of computer code using Matlab, a different analysis package; however, many of my compatriots use a software tool called "Igor." Whenever I read that name and look at my code, I can't help but think of the phrase, "I've created a MONSTER." So far, though, my initial "creations" (small coding scripts) have worked fine.

It's a bit hard to describe, but trying to learn an entirely new software package is exciting and intimidating at the same time. I imagine it is something like a skilled woodworker learning to do metal work. Some of the skills transfer readily, but there are still so many new techniques to learn. Luckily, I have the good fortune of having experts like Stephen Springston and Larry Kleinman sitting in the same room with me.

With the lull in local activities, my thoughts turn further afield. For example, researchers at PNNL and Argonne National Laboratory have collaborated to establish a surface measurement site north of Oklahoma City. We can see an image of the sky at this remote site updated every five minutes from this website: ftp://ftp.arm.gov/pub/sites/parsl/recent.html.

Stephen Springston, BNL

Gunnar Senum, BNL

The Cloud, Aerosol, and Precipitation Spectrometer removed from the aircraft for servicing and maintenance. – (Enlarge image)

Daily Log - June 12, 2007

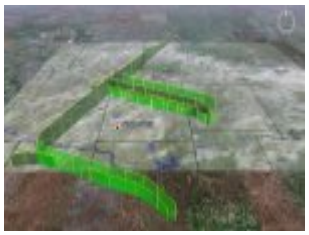
The G-1 did not fly today, so I spent part of the day examining results from yesterday's successful flight. One of the first steps involves comparing independent measurements of the same quantities (or related quantities) measured by different instruments and researchers. Two days ago, I described the Gerber probe, which measures the total water content and total surface area of the cloud droplets sampled. From the combination of these two properties, we can also infer the average size of the sampled cloud droplets.

To check the measurements from the Gerber probe I've been working with Stephen Springston and Gunnar Senum of Brookhaven National Lab.

Stephen and Gunnar are experts with a number of the instruments aboard the G-1. They have deployed a Cloud, Aerosol, and Precipitation Spectrometer (CAPS) by Droplet Measurement Technologies aboard the G-1 in support of field experiments for the past three years. The CAPS probe is actually several independent probes rolled into one system. It measures temperature, relative humidity, airspeed and altitude, liquid water content, and particle size. It even scans images of particles as they zip past. Comparing the measurements of liquid water content and particle size from the Gerber probe and the CAPS will allow us to improve our overall determination of these cloud properties.

These comparisons are very important from a technical perspective, but they are also exciting from a personal perspective. Stephen has been involved with the G-1 for more than 10 years and Gunnar has been involved for several years as well. In contrast, this is my very first mission not only with the G-1 but with aircraft measurements as a whole. The close collaboration intrinsic to field experiments naturally brings new researchers (me, in this case!) in direct contact with respected leaders in the field. This adds an interesting dynamic and is personally and professionally very exciting.

Preparing the Gulfstream-1 aircraft for departure. The yellow cart to the left of the landing gear provides power to start both main engines. The heavy black cables beneath the aircraft provide power to the scientific instrumentation until after the engines are running. – (Enlarge image)



Composite of Google Earth image of terrain, satellite map of clouds, and G-1 transmitted flight path. This image was generated on the fly while the G-1 was aloft, using software developed by Craig Strait, at Pacific Northwest National Laboratory. – (Enlarge image)

Daily Log - June 11, 2007

Today was a great day! After the cancelled mission plans yesterday, we were all excited to have another go at it. Arriving at the hangar before 7:00 AM, we began preparing the G-1 for an 11:00 AM departure time. In the photo, the G-1 is almost ready to go. Note the orderly arranged cables beneath the wings and body of the aircraft. While aloft, generators aboard the aircraft supply all the electrical power that our instrumentation needs, but while the engines are shut down on the ground, we supply external power using the heavy cables shown in the photo. These cables are my life line! Before the G-1 can depart I need to disconnect these cables from the aircraft - but not until the turbines are running full swing. By walking closely along the cable lines I keep safely away from the spinning propellers and the scorching jet exhaust. But talk about LOUD!! Thank goodness for earplugs and headphones! I wear both at the same time.

Today the G-1 flew a coordinated pattern with the NASA King Air, upwind and downwind of Oklahoma City. By measuring the particulate matter, aerosols, and trace gases, we hope to identify the plume of air leaving this urban area and to understand the effect it has on the formation, properties, and behavior of clouds. For example, clouds require small aerosol particles in order to form (nucleate) cloud droplets from water vapor. But it is also known that the presence of aerosols may at times suppress cloud formation. A key goal of this field experiment is to improve our understanding of these complex interdependencies between clouds and aerosols.

Science meets nature in Oklahoma – (Enlarge image)

The gold-colored instrument is the Gerber probe. A laser is located inside the end attached to the airplane. Light sensors are located in the end farthest from the airplane. As the plane flies through clouds, some of the cloud droplets pass through the cylindrical opening and scatter light from the laser beam into the light sensors. With this probe, we can determine the liquid water content, the total surface area, and the cloud droplet size. – (Enlarge image)

Daily Log - June 10, 2007

As I was sitting at my computer this morning, I noticed some Oklahoma wildlife right outside the window. The window glass is tinted dark to block sunlight so apparently the wildlife didn't even notice me. The bunny rabbit would perch on its hind legs to nibble at the tender leaves while at least a dozen little birds flitted about on the ground and in the bushes. A pretty nice way to start the morning!

Today we anticipated flying a coordinated mission with multiple aircraft. However, the early morning weather briefing suggested a low likelihood of finding the small puffy cumulus clouds that most interest the scientists so our flight plans were cancelled, saving the flight hours for more optimal conditions.

Whenever the aircraft is on the ground we take the opportunity to service it and to check and/or calibrate our instrumentation. This time was no exception. Here is a picture of a "Gerber probe." The Gerber probe uses a laser to measure properties of clouds and cloud droplets as the aircraft flies through them. I removed it, disassembled and cleaned it, reassembled it, and then re-installed. This was my first time to service this instrument so you can imagine my relief when it worked like a charm after I turned it back on. Woohoo!

The G-1 is readied for CHAPS at its home base in Pasco, WA – (Enlarge image)

Pictured from left to right: Yin-Nan Lee, John Jayne, Betsy Andrews, Connor Flynn, Matt Newburn, Claudio Mazzoleni, Ian McCubbin, Yury Desyaterik, Liz Alexander, John Hubbe, Gunnar Senum, Jason Olfert, Carl Berkowitz, Stephen Springston, Peter Daum, John Ogren, Larry Berg. Photo taken by Lynne Roeder.- (Enlarge image)

Daily Log - June 9, 2007

Hello all! Welcome to the first posting of Flynn's Field Files. Last week we arrived safely in Oklahoma with the Gulfstream-1 aircraft, after a brief diversion to Phoenix to avoid strong storms. Since then, we have kept very busy working 12+ hour days preparing the aircraft and instrumentation for the mission, and performing initial flights. As of today, all of the instruments have been integrated aboard and have been tested in pre-campaign test flights, and we have flown one Oklahoma City flight. The instruments aboard the G-1 represent the state-of-the-art in atmospheric aerosol measurements and are fielded by leading researchers from across the country, with whom I will have the distinct pleasure of working!

Over the next three weeks, in addition to providing on-the-fly updates of events during this intensive field campaign, we'll highlight several of the research teams and the measurements they'll be conducting from the G-1. Here is a photo of most of the G-1 team with the tail of the G-1 extending out of the hangar doors.